EFFECT OF SODIUM NITRITE ON FLAVOR OF CURED PORK

SUMMARY—The effect of sodium nitrite in the curing pickle upon the flavor of the resulting cured and cooked pork roasts was investigated. Paired pork longissimus dorsi roasts were cured with varying amounts of salt, and with or without sodium nitrite. The effect of smoke was also studied. Taste panelists were able to select correctly ($P < 0.05$ or 0.01) the different sample in triangle tests and indicated that the pork roasts cured with sodium nitrite had more cured pork flavor. Smoke did not mask this flavor, which was different from that attributable to the salt used in the curing pickle.

INTRODUCTION

THE CURING of meat is fundamentally a process of salting and was used originally as a method of preservation. Saltpeter (KNO_3) also has long been used to protect meat from spoilage and discoloration (Hoagland, 1908). The original preserving function of meat curing has been changed to one of flavor and color development, to satisfy present-day consumer tastes.

The characteristic heat-stable red color of cured meat is due to the interaction of nitrite with the myoglobin of meat to form the pigment, nitroso-myoglobin. When nitrate was used in the curing process, bacteria were necessary to reduce the nitrate to nitrite for color fixative purposes. Since 1929 the use of either sodium or potassium nitrite has been approved by the U.S. Meat Inspection

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Table 1—Composition of the curing pickles, residual nitrite, sugar, sodium chloride, phenol content of cooked roasts and taste panel results.

	Pickle			Cooked roasts					
Trial	NaCl (%)	Sugar (%)	Nitrite (ppm)[1]	Residual nitrite (ppm)[2]	Sugar[6] (%)	NaCl[6] (%)	Phenols (mg/100 g)	Triangle test	Two-sample test
1	4.70	1.20	300	37	0.21	2.15	–	9/18[3] NS	
2	4.70	1.20	300	32	0.21	2.17	–	7/18 NS	
3	4.70	1.20	300	41	0.25	2.05	–	12/18**	
4	4.70	1.20	300	30	0.09	1.79	–	10/18*	
5	4.70	1.20	300	30	0.10	1.81	–	12/18**	
6	2.35	1.20	300	39	0.23	1.04	–	11/18*	15/18[4]**
7	2.35	1.20	300	42	0.29	1.14	–	10/18*	14/18*
8	2.35	1.20	300	19	0.28	1.01	–	21/36**	32/36***
R[5]	2.35	1.20	300	39	0.16	1.11	–	–	21/36 NS
9_L	4.70	1.20	–	–	0.19	2.20	–	–	
R	4.70	1.20	–	–	0.14	2.11	–	–	
10_L	2.35	1.20	300	35	0.16	1.00	–	–	23/36 NS
R	2.35	1.20	300	38	0.15	1.21	–	–	20/36 NS
11_L	4.70	1.20	–	–	0.14	2.14	–	–	
12	–	–	300	23	–	–	–	14/23**	19/23**
13	–	–	300	22	–	–	–	11/19*	16/19**
14	–	–	300	22	–	–	–	11/18*	14/18*
15	2.35	1.20	300	32	0.33	0.97	3.21	17/26***	22/26***
16	2.35	1.20	300	19	0.32	1.15	9.22	14/22**	18/22**
17	2.35	1.20	300	26	0.25	1.02	6.20	13/18***	17/18***

[1] Either right or left sample of the pair.
[2] In sample cured with $NaNO_2$.
[3] Number of correct selections/number of panelists.
[4] Number of "more cured flavor" selections of $NaNO_2$ cured samples/number of panelists.
[5] R = Right, L = Left.
[6] Average of paired roasts.
NS = not significant, * significant at $P < 0.05$; ** significant at $P < 0.01$; *** significant at $P < 0.001$.

Division. The amount is limited, so that the finished products contain no more than 200 ppm of sodium nitrite.

The distinctive flavor of cured meat may be due to the salt, sugar, nitrite or smoke, or both, used or applied during the curing process. Brooks et al. (1940) studied the function of nitrite in the curing of bacon and hams and reported that "the characteristic 'cured' flavour of bacon is due primarily to the action of nitrite on the flesh, and a satisfactory bacon can be made by using only sodium chloride and sodium nitrite." Taste panel data were not presented.

The present study was undertaken to determine if taste panelists could detect differences in pork cured with nitrite from pork cured without nitrite.

EXPERIMENTAL

PAIRED (right and left) sections of pork longissimus dorsi muscles were removed from 68.2–75.0-kg pork carcasses. The sections were from either the 10th to last thoracic vertebrae or the first to last lumbar vertebrae. The boneless roasts ranged from 0.45–1.08 kg in weight. After removal, they were packaged in Cryovac bags under partial vacuum, frozen and stored at −17.0°C until used (3–4 weeks).

Prior to curing, paired roasts were defrosted for 12 hr at 3°C, weighed and placed in the curing pickle in plastic bags and cured for 3 days at 2.0–3.0°C. Ratio of pickle to meat was always 2:1 (w/w). In every trial one of the paired samples was cured with $NaNO_2$ in the pickle and the other roast without $NaNO_2$. The curing pickles contained either 0.00, 2.35 or 4.7% NaCl; 0.00 or 1.20% sugar and 0 or 300 ppm of sodium nitrite.

The cured roasts were cooked in a 170°C oven to an internal temperature of 85.6°C. The cooked roasts were sliced into 5-mm-thick slices with a meat slicer. When the effect of smoke was studied, the slices were smoked (hardwood sawdust smoke) at 53.3°C and 34% R.H. for 10 min in an air-conditioned smokehouse. Some of the center slices of each roast were used for chemical analyses and the remainder for presentation to a nontrained flavor panel.

The triangle taste test was used to determine if a difference could be detected between the samples cured with $NaNO_2$ and those cured without nitrite. Red lights were used to mask sample color differences, but this procedure was discontinued in favor of a test in which the panelists were blindfolded and served the samples. In the triangle test the different sample was served first 1/3 of the time, second 1/3 of the time, and last 1/3 of the time. The samples were at room temperature when presented to panel members. The 2-sample taste test followed the triangle test. The panelists were asked, "Which of the samples had more 'cured flavor'"?

The samples cured without nitrite were served to the blindfolded panelists in an alternate order, i.e., panelist A received the nitrite-cured sample first and panelist B the no-nitrite-cured sample first, etc. All panelists used for the triangle tests were given the 2-sample tests, regardless of whether they had selected correctly the different samples. Statistical significance was determined by reference to Ellis (1961) for the triangle test and to Roessler et al. (1956) for the 2-sample test.

Chemical analyses for residual sodium nitrite, sodium chloride, sugar and phenols (smoked samples) were made on the center portions of the cooked roasts. Sodium nitrite and sodium chloride were determined by recommended methods (A.O.A.C., 1965). The method of Folin and Wu (1920) was used for determination of glucose. The sucrose in the sample was inverted by the method described by Harrow et al. (1955). The amount of sugar in the sample was the difference between glucose values before and after inversion. Phenols were estimated by the colorimetric method of Tucker (1942). Results are reported as mg phenols per 100 g sample.

RESULTS & DISCUSSION

COMPOSITION of the curing pickles used, data of some chemical analyses of the cooked roasts and results of the triangle and 2-sample taste tests are presented in Table 1. In each of the 17 trials listed, paired right and left roasts were used. Samples cured with $NaNO_2$ were equally divided between right and left roasts.

The taste panel tests of trials 1–5 were performed in booths employing red illumination to mask the normal visual difference between the roasts cured with nitrite and those cured without nitrite. In trials 1 and 2 no statistical difference in the triangle taste test was obtained. The next 3 trials (3, 4 and 5) resulted in correct selection of the different sample at a significant ($P < 0.05$ or 0.01) level. In all subsequent trials, samples were served to blindfolded panelists to eliminate the possibility of color difference being used rather than flavor difference.

The sodium chloride concentrations used did not appear to interfere with the panelist's ability to select the correct different sample in the triangle test when the results of trials 3, 4 and 5 are compared with trials 6, 7 and 8. The effect of 1.0 and 2.0% sodium chloride concentration combined with or without the nitrite cure, respectively, was studied in trials 9, 10 and 11. In each trial the lower salt concentration was in the samples cured with nitrite. While the 2-sample test did not demonstrate statistical significance, more panelists (64) selected the lower salt-nitrite-cured samples than those (44) who chose the higher salt-no-nitrite-cured samples as having "more cured flavor."

3 trials (12, 13, 14) were conducted in which neither salt nor sugar was added to the curing pickle. 1 of the roast pairs was

cured in a nitrite-containing pickle, whereas the pairmate was placed in distilled water. Both the triangle and the 2-sample tests showed that the panelists selected correctly the different sample and chose that sample with nitrite ($P < 0.05$ or 0.01) as having "more cured flavor."

Smoking is a process often applied to cured pork. Trials 15, 16 and 17 were conducted to determine if the smoke flavor would mask or dilute the cured meat flavor that the panelists indicated was present in the nitrite-cured sample and not present in the sample cured without nitrite. In spite of the heavy smoke concentration as shown by the phenol data, the panelists chose the correct different sample in the triangle test and indicated that the nitrite-cured smoked sample had "more cured flavor" than the smoked samples cured without nitrite ($P < 0.01$ and 0.001).

Results reported are in agreement with those of Brooks et al. (1940), who stated that a sodium chloride and sodium nitrite cure would produce a bacon satisfactory to English consumers. Wasserman and Talley (1969) reported that statistical significance in triangle tests was obtained only when the different sample was a smoked sample and not when the different sample was an unsmoked sample. In the present study the no-nitrite-cured and nitrite-cured samples were used equally as often as the different sample. Statistical significance was noted in 12 of the 14 triangle tests.

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